Carl Parker, Science, Examine DNA to Solve a Bacteria Problem in Pismo Beach

By Mary McNally

Since San Luis Obispo County health officials began testing coastal water for contamination in 2001, an alarming number of safety advisories have been issued warning people of high levels of potentially dangerous bacteria at Pismo Beach.

Pigeons were suspected to be the culprit, but officials couldn’t develop a strategy to minimize contamination until they determined the source.

That's when they turned to Cal Poly's Environmental Biotechnology Institute (EBI) to solve the mystery – giving dozens of students and a handful of faculty members a chance to make a real-world difference.

The resulting study spanned three years. In the end, Cal Poly confirmed officials' first inclination about the source of the pollution.

"The preponderance of data indicates the pier is the physical origin of contamination and pigeons have been the main source," said Christopher Kitts, study supervisor and Biology Department chair.

Along the way, the hands-on experience conducting lab tests and statistical analysis in a multi-year study transformed participating students into accomplished field researchers and skilled lab technicians.

Intriguing Results

Volunteers, students and Cal Poly's Center for Coastal Marine Science were enlisted to collect samples from various sites along the beach, in the water and at the South County wastewater outlet. Samples were taken in hourly, daily and weekly intervals, while tides, wave direction and current were monitored to detect patterns.

Sampling done during a single summer indicated 43 out of 60 days had at least one site that exceeded safe bacterial levels. During incoming tides, at least one site per hour exceeded the safety level 96 percent of the time.

Two primary testing protocols were conducted, both of which challenged the students to perform complex lab studies using state-of-the-art equipment.

To determine the source species, the students extracted DNA from E. coli in Pismo Beach sea water samples and matched it to strains from a national library of E. coli DNA fingerprints. "E. coli is a relatively large component of human intestinal flora, and that makes it a good indicator of fecal contamination," said Kitts.

They also extracted DNA from bacteria in fecal samples and matched that to DNA from bacteria known to inhabit the intestines of species including humans, dogs, cows and horses.

The research produced some intriguing results. Evidence of dog feces in the water was more common on the weekend. And human deposits were more common in the middle of the week and dramatically higher around the July Fourth holiday.

However, neither dogs nor people contributed enough contamination to trigger safety warnings.

Instead, birds were the only source of feces consistent with all the data collected. And pigeons were by far the most common birds on and around the pier.

Student Success

By virtue of its work in the program, the EBI has received a grant to develop a faster, cheaper library of E. coli DNA fingerprints. The project has already been integrated into course curricula, so students have the opportunity to develop what Kitts hopes will be a new resource for California watershed management.

It's just one example of how students benefited from the opportunity.

"With any lab technique, there are always little things that make a difference," said fifth-year microbiology student James Chen. "Like when you're doing a DNA extraction, how do you know you're getting the optimal amount of DNA? Those are the things you learn with hands-on experience.

Monica Reynoso (B.S., Microbiology, 2009) ran the tests and taught other students to do the procedures. "She understood why we needed the level of precision we did and how to get students to follow the protocols exactly," said Kitts. "If you're a clinical laboratory technician, precision is important. Your work affects someone else's life."

"I really enjoyed the detective work involved in research," Reynoso said. "It helped me realize what I wanted my career to look like."

Reynoso now works as a DNA sequencing lab technician at Elim Biopharmaceuticals. "I work with graduates from other universities," she said, "and that makes me realize the value of my learn-by-doing education. Many of my coworkers had never seen a sequencer before they started working here. My experience at EBI gave me an advantage in the real world."